



Using Grid Computing Within the Department of Defense

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LtCol Peter Garretson
Chief, Future Technology
Branch
HQ USAF*

Mr. Richard Kundiger
Cyberspace Architect
Defense Contract
Management Agency*

* Information in this brief does not represent any official position of the U.S. Air Force or the Defense Contract Management Agency. It is solely a thought piece from the authors.

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14. ABSTRACT The Department of Defense has massive amounts of data that needs analysis. Purchase and maintenance of supercomputers to process this information, or leasing of supercomputer resources, is very expensive. DoD already has a supercomputer available to it via distributed or grid computing by making use of the millions of PCs within the department. Using CPU and memory scavenging agents DoD has to potential to harness over 70 Petaflops of compute capacity using existing equipment with minimal additional investment. This platform could then be used to perform advanced modeling, advanced simulation, deep data mining and evolutionary analysis.					
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Grid Computing Within DoD



What is Grid Computing?

- Grid Computing is a form of computing that makes use of computer resources across many disparate platforms and devices to perform work
- Allows massive parallelization of tasks and entirely new kinds of processing by pooling the total resources from many machines to create a supercomputing environment from common, inexpensive, hardware
- It can be configured to scavenge “spare” CPU cycles, unused cores, GPU’s, Memory, and disk storage to leverage DoD’s existing, under-utilized, infrastructure



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Background

- The Department of Defense has massive amounts of data that needs analysis
 - Existing methods of analyzing this data are slow and ineffective
 - Many disparate systems are purchased or leased to perform analysis
- Modeling and simulation is typically outsourced
 - Computers capable of doing advanced modeling and simulation are very expensive to purchase, manage, house, cool and power
- DoD's problems are not unique. Research, Industry, and Academia are increasingly turning to Grid Computing



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Premise

- Provide a platform that allows DoD to self perform:
 - Advanced modeling
 - Advanced simulation
 - Deep data mining and analysis of extremely large data sets.
 - Iterative or “evolutionary” analysis
- Do it by using untapped, existing computational potential



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Premise

- There is a huge untapped potential
- CPU time is the amount of time the CPU is actually executing instructions
- The rest of the time the CPU sits idle, awaiting system or user instructions

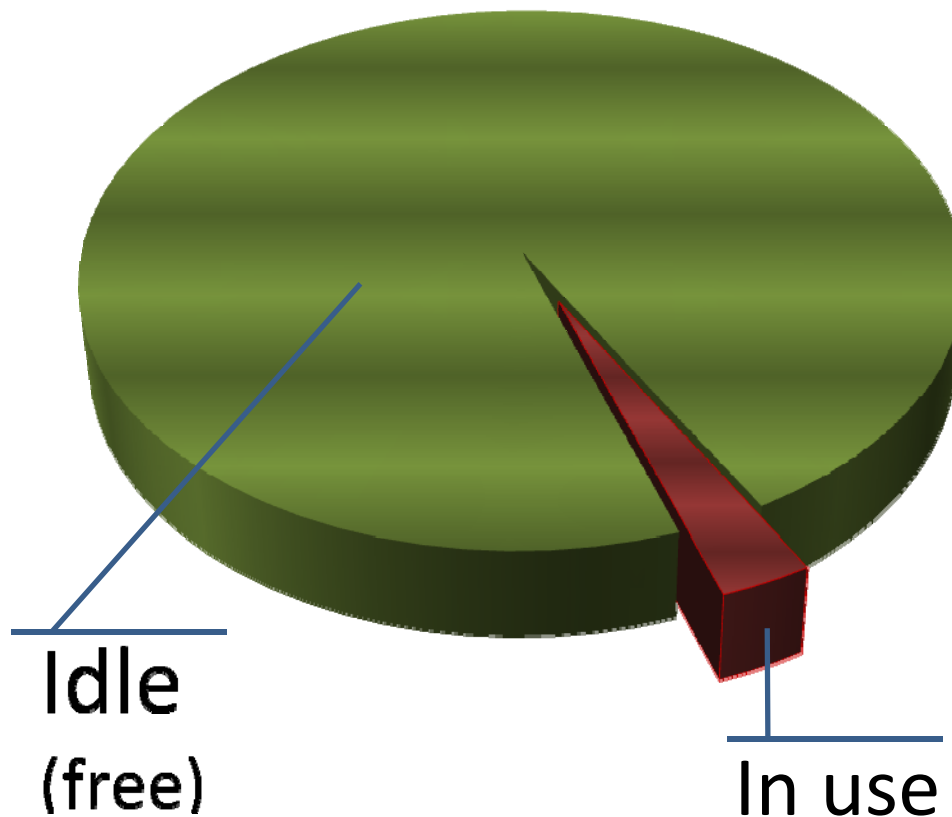


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Premise

Idle CPU Time



- CPU time at idle is typically between 3%-7% leaving 93-97% free



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Premise

- Many DoD PC hard drives go unused, or very minimally used, due to availability of networked storage
 - This may lead to 10's or 100's of free Gigabytes of space
- Computer memory (RAM) is increasing leaving hundreds of Megs, if not Gigs, of unused memory at idle
- Gartner identifies Grid computing as one of the top ten most disruptive technologies to shape information technology over the next five years.

Gartner



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Premise

- Modern computers can provide a conservative estimate of 3 GigaFLOPS each of computing potential.
 - A GigaFLOP is a billion floating point operations per second
- DoD has approximately 5 million computers
- A PetaFLOP is One Quadrillion Floating Point Operations / Second
- Until June of 2009 no computer had ever exceeded the PetaFLOP level.



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Premise

- The largest supercomputer in the world today is 1 PetaFLOP
- DoD's theoretical computing potential is 150 PetaFLOPS
- 75 PetaFLOPS if only used half the day as compute nodes in a Grid during off hours
 - $(3\text{GigaFLOPS} * 5,000,000 \text{ PCs}) / 2$ (12 hours for work, 12 for Grid computing) = 75 PetaFLOPS

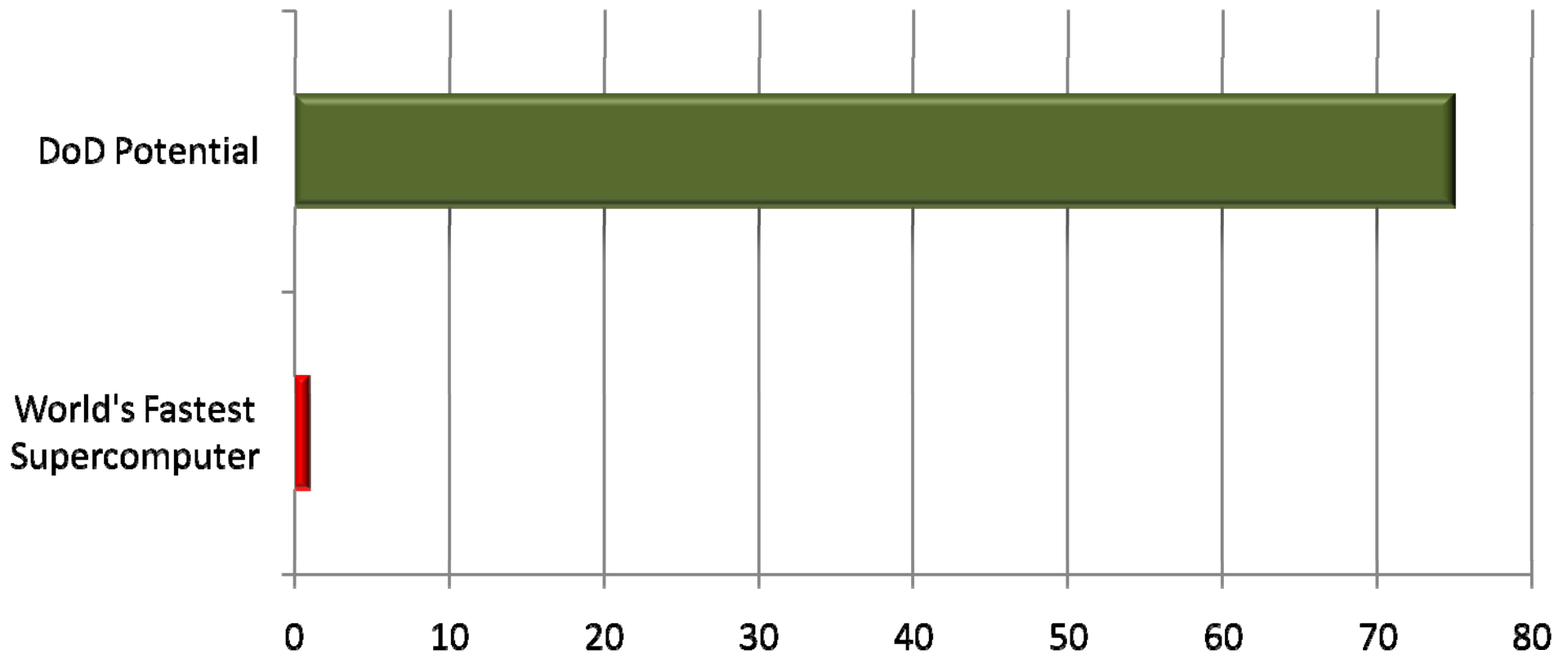


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Premise

- DoD already owns the largest supercomputer in the world 75 fold





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Examples in Research



- Search for Extraterrestrial Intelligence (SETI@HOME)
 - Probably one of the most well known
 - Uses Berkeley Open Infrastructure for Network Computing (BOINC)
 - Over 3 million computers
- Large Hadron Collider by CERN Labs (LHC@HOME)
 - Also uses BOINC
 - Used to simulate particles travelling around the collider.
- Folding at home by Stanford University (Folding@HOME)
 - Studies protein folding, misfolding, aggregation and related diseases. (Alzheimers, Cancer, HIV)
 - Helps research protein based nanomachines
- And growing...





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Examples in Industry



i n v e n t



nVIDIA®



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Examples in Education

- October 2007 - IBM and Google unite to provide Grid computing data centers for university education and research
- Universities involved are: Stanford University, MIT, University of California, Berkeley, the University of Maryland and the University of Washington
- Utilizes a public version of Google's MapReduce and Google File System technologies known as Hadoop

The Google logo, featuring the word "Google" in its characteristic multi-colored font (blue, red, yellow, green, blue, red) with a trademark symbol.

The IBM logo, consisting of the letters "IBM" in a stylized, blue, eight-striped font, followed by a registered trademark symbol.



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Examples in Industry

- June 2008 - IBM proves they have built the first Pflop supercomputer which is known as Roadrunner
- IBM held the previous record at 478 Teraflop (Tflops) with BlueGene/L
- Roadrunner uses a mix of AMD Opterons and IBM's Cell (PowerPC) processors
- Contains 294,912 Processors in 72 racks covering 6,000 square feet.
 - DoD networks contains a *minimum* 5 million CPUs, over 17x larger than roadrunner
- Made up of mostly commodity parts
- In use by the DoE in the Los Alamos National Lab



Cost over \$133
Million Dollars!



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Examples in Industry

- Microsoft HPC++ (Windows HPC Server 2008)
 - Scales to thousands of processing cores
 - Benchmarked at 18 TeraFLOPS on 2,048 processors spread across 256 compute nodes
 - Microsoft is adding parallel computing extensions to .NET 3.5

Microsoft



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A DoD System is Deployable

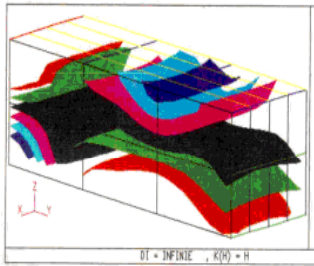
- A deployed thin client with limited permissions
 - Administrative policy regulates PC and network load
 - End user has no access to client or job data, which is encrypted
- A centrally controlled scheduler / server controls tasks
 - Jobs are signed / certified, encrypted
- Security is comparable to existing net-administered maintenance
 - Application sensitivity is addressed on a case-by-case basis
 - Solution diffuses rather than concentrates data, into small and useless snippets of information
- SIPR, being a more tightly controlled environment, is perfect for secure Grid computing.



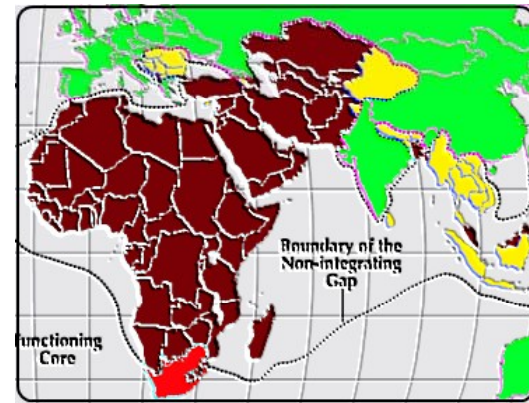
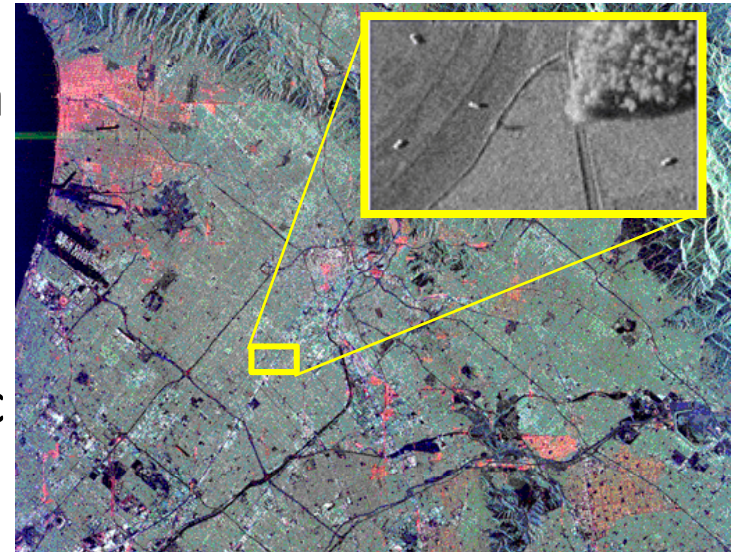
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Imagine the Possibilities



- Massively parallel wide-area search, data-fusion, target recognition
- Complete sets of parametric analysis
- Large, interactive predictive models (global instability)
- Campaign analysis models





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Questions?